NSLS-II
NATIONAL SYNCHROTRON LIGHT SOURCE II

Beamline EPS Acceptance Testing

Rev Date: 09/16/2015
Author: Barrett Clay
Approved: 09/16/2015

Title	Name	Approval Date
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Serial No	Part No	Part Rev	ECN	Rev	ECN	Rev
	Beamline: 11-BM CMS					
Deviation & Waiver:						

OP	Description	Name/Life #	Date	DR
10	Follow the ES&H and Personal Protective Equipment Requirements for the area.	R Kadyrov #25392	07/27/16	
20	Verify measuring and test equipment used for this procedure contains a valid calibration label in accordance with NSLS-II Calibration Procedure PS-QAP-0901, where applicable. The technician is responsible for notifying the technical supervisor and/or the cognizant engineer of any discrepancies occurring during the performance of this procedure. All discrepancies shall be identified and reported in accordance with NSLS-II Discrepancy Reporting Procedure PS-QAP-0002.	R Kadyrov # 25392	07/27/16	
30	BEAMLINE INFORMATION - This step shall be performed by the cognizant EPS Engineer. A) Record the relevant Beamline name on this sheet, in the box for "Part No". B) Review this entire traveler and write in the relevant drawing, software, and procedure numbers where required	R Kadyrov 25392	08/05/16	
40	INSTALLATION VERIFICATION A) List the relevant drawing(s): 21 (R4) LT-EL-BL-EI-EPS-2210-90 Drawing No.: _____ Rev. No.: A Drawing No.: _____ Rev. No.: _____ B) Verify the following items are acceptable: ✓ System layout configured per drawing(s) ✓ System Labeled / Tagged	R. Kadyrov # 25392	07/29/16	

OP	Description	Name/Life #	Date	DR
50	SOFTWARE CONFIGURATION A) Download PLC software to controller and verify it was accepted by the controller. B) Record the software part number: LT-EL-BL-EI-EPS-2110-70 Part No.: _____ Rev. No.: A	R Kadyrov 25392	07/29/16	
60	ACCEPTANCE TESTING A) List relevant testing procedure Procedure No.: PS-R-XFD-EPS-Chk_001 Rev. No.: 1 B) Verify acceptable completion of test procedure C) Attach test report to this traveler	R kadyrov 25392	08/05/16	
65	WATER LEAK DETECTION SYSTEM TEST Verify water leak detection system, as designed for this beamline, functions correctly.	R. Kadyrov 25392	08/05/16	
70	Verify All Traveler Operations Complete	R Kadyrov 25392	08/05/16	
80	REVISION HISTORY (This step is informational and does not require signoff) Rev - Description - Date A First Release 8/27/2014 B OP#65 added 9/16/15 Joe Delong removed as approver Ruslan Kadyrov added as approver			

Beam Line: 11 BM CMS

Test Date:

EPS Engineer: Ruslan Kadyrov

BL Group Leader: Masafumi Fukuto

Beam Line master spreadsheet:

https://ps.bnl.gov/phot/BeamlineSupportDocs/CMS/Controls/LT-R-XFD-CO-DR-CMS-001_Rev2.xlsx

Pre-test setup:

Connect PPS interface test box at beam line EPS/PPS interface connector.

The Beam Line Master Spreadsheet contains a comprehensive list of all EPS related signals. As this test plan is executed note the results in the "test results" column of this spreadsheet.

Test Set 1: Vacuum

Vacuum Section:

Starting conditions: pressure at or below acceptable limits, GVs open.

Simulate pressure rise (toward poor vacuum) by disabling the vacuum gauge controller channel. Ensure EPICS PVs enter proper alarm states, photon shutter closes[1] and vacuum section is isolated. Two local gate valves and one (or more, if it is required to isolate upstream section, e.g. section branching) upstream gate valve close. Record results for the following:

EPICS PV Alarm

EPS fault

Photon Shutter closes

GVx closes

GVy close:

GVz closes

Attempt to open the front end shutter and gate valves through EPICS.

Photon shutter and gate valves cannot be opened through EPICS (1)

[1] if the intensity of the beam in the section cannot cause damage to its valves, poor vacuum doesn't have to cause shutter close

Enable vacuum gauge controller and ensure EPICS alarms clear. Open gate valves and photon shutter through EPICS.

Photon shutter and gate valves can be opened through EPICS (2)

Gauge name:	EPS fault:				(1)	(2)
	Shutter:	d/s GV:	u/s GV:	D u/s:		
XF:11BMA-VA{Mono:DMM-CCG:1}	FE SH	✓	✓	n/a	✓	✓
XF:11BMA-VA{Mono:DMM-TCG:1}	—	—	—	n/a	✓	✓
XF:11BMA-VA{Mir:Tor-CCG:1}	FE SH	✓	✓	—	✓	✓
XF:11BMA-VA{Mir:Tor-TCG:1}	—	—	—	—	✓	✓
XF:11BMA-VA{FS:2-CCG:1}	FE SH	✓	✓	—	✓	✓
XF:11BMA-VA{FS:2-TCG:1}	—	—	—	—	✓	✓
XF:11BMA-VA{BT-CCG:1}	FE SH	✓	✓	—	✓	✓
XF:11BMA-VA{BT-TCG:1}	—	—	—	—	✓	✓
XF:11BMB-VA{Mir:KB-TCG:1}	—	—	—	—	—	—
XF:11BMB-VA{Chm:Det-TCG:1}	—	—	—	—	—	—
XF:11BMB-VA{BS:SAXS-TCG:1}	—	—	—	—	—	—

Simulate pressure rise (toward poor vacuum) by disabling the vacuum pump controller channel. Ensure EPICS PVs enter proper alarm states, photon shutter closes[2] and vacuum section is isolated. Two local gate valves and one upstream (or more, if it is required to isolate upstream section, e.g. section branching) gate valve close. Record results for the following:

EPICS PV Alarm

EPS fault

Photon Shutter closes

GVx closes

GVy closes

GVz closes

Attempt to open the front end shutter and gate valves through EPICS.

Photon shutter and gate valves cannot be opened through EPICS (1)

Enable vacuum pump controller and ensure EPICS alarms clear. Open gate valves and photon shutter through EPICS.

[2] if the intensity of the beam in the section cannot cause damage to its valves, poor vacuum doesn't have to cause shutter close

Photon shutter and gate valves can be opened through EPICS (2)

Repeat for each vacuum section on beam line. For the sections adjacent to Front end and End Station, also simulate poor vacuum signal from remote systems.

EPS fault:	Front end:	End station:
Photon Shutter closes	✓	n/a
GVx closes GV2	✓	n/a
GVy closes	n/a	n/a
GVz closes	n/a	n/a
Shutter and GVs cannot be opened	✓	n/a

Gauge name:	EPS fault:				(1)	(2)
	Shutter:	d/s GV:	u/s GV:	D u/s:		
XF:11BMA-VA{BC:1-IP:1}	FE SH	—	✓	n/a	✓	✓
XF:11BMA-VA{Mono:DMM-IP:1}	FE SH	✓	✓	—	✓	✓
XF:11BMA-VA{Mir:Tor-IP:1}	FE SH	✓	✓	—	✓	✓
XF:11BMA-VA{FS:2-IP:1}	FE SH	✓	✓	—	✓	✓
XF:11BMA-VA{BT-IP:1}	FE SH	—	✓	—	✓	✓
XF:11BMA-VA{BT-IP:2}	FE SH	—	✓	—	✓	✓
XF:11BMA-VA{BT-IP:3}	FE SH	—	✓	—	✓	✓

Test Set 2: Water flow

Water flow Section:

Record initial flow through section with all valves fully open.

Slowly close supply valve and record the LOW and LOW LOW PV Alarm levels.

If the channel is associated with an EPS action (e.g. XFD-EPOS), also register the flow at which the EPS fault occurs. Ensure cable disconnection results in EPS action.

Repeat for each water circuit on beam line.

Sensor name:	Nominal flow:	LOW:	LOLO:	EPS:
XF:11BMA-OP{Mono:DMM}F-I	0.49 GPM	0.25	0.2	FE SH
XF:11BMB-ES{Det:WAXS}F-I	0.54 GPM	0.4	0.3	FE SH

Test Set 3: Thermal

For each temperature transducer ensure the temperature measurement reports expected value.

Attach an appropriate adaptor and transducer simulator to the temperature input of the EPS system (remote IO chassis or Armor Block). Raise the temperature above each of the HI and HIHI PV alarm limits and ensure the alarm is reported. If the transducer is associated with an EPS interlock, continue to raise the temperature until the EPS trip level is exceeded. Ensure the appropriate EPS mitigation process occurs. Ensure channel cable disconnection results in EPS action.

Sensor name:	Temperature: °C	HI: °C	HIHI: °C	EPS:
XF:11BMA-OP{Msk:1}T-I	23.8	40.0	50.0	FE SH
XF:11BMA-OP{Mono:DMM}T:0-I	25.6	40.0	50.0	FE SH
XF:11BMA-OP{Mono:DMM}T:1-I	25.3	40.0	50.0	FE SH
XF:11BMA-OP{Mono:DMM}T:2-I	25.4	40.0	50.0	FE SH
XF:11BMA-OP{BS:1}T-I	23.5	40.0	50.0	FE SH
XF:11BMA-OP{Mir:Tor}T:1-I	23.4	35.0	40.0	FE SH
XF:11BMA-OP{Mir:Tor}T:2-I	23.4	35.0	40.0	FE SH
XF:11BMA-OP{BS:2}T-I	23.6	35.0	40.0	FE SH
XF:11BM{RG:A1}T-I	23.1	—	—	—

FE SH - Front End Shutter

"—" no EPS action, as expected

Test Set 4: EPS/PPS interface

For the primary Photon Shutter:

Front End: If *FRONT END ENABLE STATUS* and *FOE SECURE* and not *USER INTERLOCK* command the front end shutter to open.

Front end opens and ***FRONT END OPEN STATUS*** = OPEN: ✓

Command the front end shutter to close.

Front end closes and ***FRONT END OPEN STATUS*** = CLOSED: ✓

With the front end open force a user interlock.

Front end closes and ***FRONT END OPEN STATUS*** = CLOSED: ✓

Attempt to open the front end shutter through EPICS while not all gate valves in white-beam region down to next secondary shutter are open.

Front end cannot be opened through EPICS: ✓

For each secondary photon shutter:

If PHOTON SHUTTER x ENABLE STATUS = 1 (ABILITY TO OPEN) and ESEE x SECURE command the shutter to open.

Shutter opens and **PHOTON SHUTTER x *OPEN STATUS*** = OPEN ✓

Command the shutter to close.

Shutter closes and **PHOTON SHUTTER x *OPEN STATUS*** = CLOSED ✓

Attempt to open the shutter through EPICS while not all gate valves in white-beam region downstream the shutter are open.

Shutter cannot be opened through EPICS: ✓

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Appendix A

Differential Vacuum Interlocks

Remove the analog output cable from the MKS vacuum gauge controller for the Pirani gauges of XF:11BMB-VA{Mir:KB-TCG:1} and XF:11BMB-VA{Mir:KB-TCG:1} signals. Inject with two "Dial-A-Volt" voltage simulators (e.g. DATEL DVC-350A) a voltage (nominal 2.95V) to simulate a vacuum level in each of these chambers that are within 0.1 millibar (0.075 torr) of the other but between 0.25 and 100 millibar of pressure. Record the nominal pressure level used for differential testing. **Pressure** 0,22 m bar

Open Gate Valve XF:11BMB-VA{Slt:4-GV:1} . Verify the front end shutter can be enabled. Raise slowly the analog voltage of one vacuum signal level until the gate valve trips closed. Record the pressure level that creates the trip. Verify that the Front End is disabled. Return analog signal level back to previous pressure level. Open the gate valve and verify that the Front End is again enabled. Raise slowly the analog voltage of the other vacuum signal level until the gate valve trips closed. Record the pressure level that causes a trip. Verify that the Front End is disabled. Return analog signal level back to previous pressure level. Open the gate valve and verify that the Front End is again enabled.

Vacuum	Trip Pressure	Gate valve closed	FE disabled
XF:11BMB-VA{Mir:KB-TCG:1}	0,42	✓	—
XF:11BMB-VA{Mir:KB-TCG:1}	0,42	✓	—

Raise the simulated pressure level to 125 mbar for both gauge signals. Vary one signal by more than 2 millibar and verify that a trip condition does not occur. **No Trip** ✓

Remove the analog output cable from the MKS vacuum gauge controller for the Pirani gauges of XF:11BMB-VA{Chm:Det-TCG:1} and XF:11BMB-VA{BS:SAXS-TCG:1}signals. Inject with two "Dial-A-Volt" voltage simulators (e.g. DATEL DVC-350A) a voltage (nominal 2.95V) to simulate a vacuum level in each of these chambers that are within 0.1 millibar (0.075 torr) of the other but between 0.25 and 100 millibar of pressure. Record the nominal pressure level used for testing. **Pressure** 0,22 m bar

Open Gate Valve XF:11BMB-VA{Chm:Det-GV:1}. Verify the front end shutter can be enabled. Raise slowly the analog voltage of one vacuum signal level until the gate valve trips closed. Record the pressure level that creates the trip. Verify that the Front End is disabled. Return analog signal level back to previous pressure level. Open the gate valve and verify that the Front End is again enabled. Raise slowly the analog voltage of the other vacuum signal level until the gate valve trips closed. Record the pressure level that causes a trip. Verify that the Front End is disabled. Return analog signal level back to previous pressure level. Open the gate valve and verify that the Front End is again enabled.

Vacuum	Trip Pressure	Gate valve closed	FE disabled
XF:11BMB-VA{Chm:Det-TCG:1}	0,42	✓	—
XF:11BMB-VA{BS:SAXS-TCG:1}	0,42	✓	—

Raise the simulated pressure level to 125 mbar for both gauge signals. Vary one signal by more than 2 millibar and verify that a trip condition does not occur. **No Trip** ✓

Appendix B

End Station Pump Logic

Set or confirm the nominal EPICS float derivative (dP/dT) trip variable for both End Station Pumps #1 and #2 to 100 mbar/sec.

Remove the analog signals from the Pfeifer PCR 260 Compact Pirani Capacitance Gauges used on the End Station sections #1 and #3 with the output signals from a two channel wave form signal generator (e.g. Tektronix AFG310). Set the #3 channel to a fixed DC value shown as the nominal voltage in the below tables. Set the function generator for a rising ramp wave form with peak-to-peak voltage amplitude of 0.5 (±0.25) volts. Apply a DC offset identical to the nominal voltage applied to the #3 channel. Set the frequency of the ramp function to a lower frequency than the anticipated Calc. Trip frequency. Attach the running signal generator signal to section #1. Turn ON End Station pump #1 and verify this pump does not trip OFF. Raise the frequency of the function generator until pump #1 trips OFF. Record the frequency of the ramp waveform. Repeat this test for all four nominal pressure levels, remembering to apply a new DC offset for both signals.

Test dP/dt #1

P (mbar)	Nominal V (DC)	Calc. Trip (HZ)	Held	Meas. Trip (HZ) f	dP/dt trip meas.
			Hz		
10	6.5	8.7	6.8	6.9	79.4
30	6.98	2.9	1.8	1.9	65.6
100	7.5	0.87	0.44	0.46	52.9
300	7.97	0.29	0.11	0.12	41.44

Swap the two signal cables from the signal generator so that the ramp waveform is now attached to channel #3. Turn ON End Station pump #1 and verify this pump does not trip OFF. Raise the frequency of the function generator until pump #1 trips OFF. Record the frequency of the ramp waveform. Repeat this test for all four nominal pressure levels, remembering to apply a new DC offset for both signals.

Test dP/dt #3

P (mbar)	Nominal V (DC)	Calc. Trip (HZ)	Held	Meas. Trip (HZ) f	dP/dt trip meas.
			Hz		
10	6.5	8.7	6.8	6.9	79.4
30	6.98	2.9	1.8	1.9	65.6
100	7.5	0.87	0.44	0.46	59
300	7.97	0.29	0.11	0.12	41.44

Replace the analog signals from the Pfeifer PCR 260 Compact Pirani Capacitance Gauges used on the End Station sections #1 and #3.

Remove the analog signal from the Pfeifer PCR 260 Compact Pirani Capacitance Gauges used on the End Station sections #2. Apply the ramp waveform of the signal generator to the channel #2 input. Turn ON End Station pump #2 and verify this pump does not trip OFF. Raise the frequency of the function generator until pump #2 trips OFF. Record the frequency of the ramp waveform that caused this trip. Repeat this test for all four nominal pressure levels, remembering to apply a new DC offset.

Test dP/dt #2

Hz

P (mbar)	Nominal V (DC)	Calc. Trip (HZ)	Held	Meas. Trip (HZ) f	dP/dt trip meas.
10	6.5	8.7	0,8	6.9	79.4
30	6.98	2.9	1,8	1,9	65,6
100	7.5	0.87	0,44	0,46	53
300	7.97	0.29	0,11	0,12	41.44

To calculate the measured pressure derivative (dP/dt) the following formula is provided:

$$\frac{dP}{dt} = \frac{P * f}{2 * log_{10}(e)} \cong \frac{P * f}{0.8686}$$

Enter the calculated number in the provided column.